Numerical Analysis of the Sea State Bias for Satellite Altimetry

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The sea state bias (SSB) correction remains among the major limiting factors of altimeter sea level measuring accuracy. Theoretical understanding of its dependence on the sea state has been achieved only for an idealized case of a unidirectional sea characterized by a unimodal spectrum [Glazman and Srokosz, JPO, 21(1 1), 1991]. For simple sea conditions, this model yielded reasonable agreement with field observations and facilitated development of an empirical geophysical model function [Fu and Glazman, JGR, 86(C3), 1991] based on the notion of a pseudo wave age. However, under more realistic sea conditions, observed variations of SSB cannot be explained using the idealized theory. Recent measurements showed that the Fu-Glazman empirical model also has significant drawbacks: it underestimates the range of SSB variations and leads to considerable errors due to its failure to account for the actual, two-dimensional structure of wave spectra.

Presently, we report art investigation of effects of two-dimensional multimodal wave spectra. The work is based on numerical modeling with realistic wave fields containing swell and having an arbitrary angular spectral distribution. The following findings appear to be of particular interest: 1) Contrary to the common perception, sea swell has art appreciable effect on SSB: for a given wind-driven sea, the presence of swell causes a reduction of SSB by up to 30 percent. 2) Hidden multimodal structure (that is, when two-dimensional spectra contain separate peaks - for swell and wind seas, while frequency spectra look unimodal) results in an appreciable change of SSB. 3) For unimodal, purely wind-driven seas, the influence of the angular spectral width is relatively unimportant, i.e. a unidirectional sea provides a good model for SSB calculations in the absence of swell. 4) The pseudo wave age is generally a much better indicator of SSB than the actual wave age. 5) SSB can be as high as five percent of SWH, i.e. greater than predicted by present empirical model functions.